

SHELL SEMS PROJECT
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Sandia National Laboratories
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1.0 Current Status

All major mechanical subassemblies necessary to complete the SHELL SEMS and the shipboard command unit are on hand, with the exception of underwater cables and connectors. Electrical subassemblies have been fabricated and are being functionally tested. Contract negotiations are under way with GEOMAREX of La Jolla, California to provide support for the deployment of the SHELL SEMS. Deployment is currently scheduled for April 3.

An associated analysis, funded by the government, of background noise resulting from overhead wave action has been completed. A follow-on analysis of soil-seismic probe interaction is under way.

2.0 Plans for the Next Quarter

Software will be written and tested on the integrated SEMS electronics. Quality tests and thermal cycling will be performed once the software is operational. Assembly tests and probe calibration will then be conducted, followed by functional tests of the completed assembly. We anticipate having a fully checked and tested unit ready for shipment during the latter part of March.

Analysis of soil-probe interaction will continue. We expect that most of this will be completed this quarter. Eventually these results should lead to test procedure that will allow us to measure soil-probe interaction effects and properly analyze the data collected, making necessary corrections. These tests, if necessary, will be done on a special test probe some time after installation of the SHELL SEMS.

3.0 Configuration

The overall configuration of the SHELL SEMS and its seismic

probe are shown in Figures 1 and 2. The Seafloor Platform presented in Figure 1 incorporates the battery power supply, electronics, telemetry system, and recovery float into a self-contained seismic station. The Seafloor Platform communicates with the Seismic Probe (Figure 2) via a twelve-conductor cable. The probe is located in a drilled and backfilled hole 6-7 feet deep and about 15 feet away from the Seafloor Platform. It contains the seismic accelerometers that record the three axes of vibration and the two axis magnetometer that measures north-south orientation.

The external features of the Seafloor Platform are shown in Figure 1. The principal components illustrated in that drawing are, by item number, the following:

- Item 1 Frame: used to support the other components and to protect them from nets and cables dragged by bottom fishermen.
- Item 3 Battery Pressure Vessel: contains about 2/3 of the system's lithium batteries. Power is delivered to the Electronics Pressure Vessel via an interconnecting cable.
- Item 4 Electronics Pressure Vessel: contains the remaining batteries as well as all system and telemetry electronics. It communicates with the Battery Pressure Vessel, the Seismic Probe, the Telemetry Transducer, and the Recovery Float Release via four separate interconnecting cables.
- Item 5 Recovery Float: holds 450 feet of 3/8" Kevlar recovery line, which it carries to the surface when the release mechanism is actuated. The Seafloor Platform can then be hoisted to the surface with the recovery line.

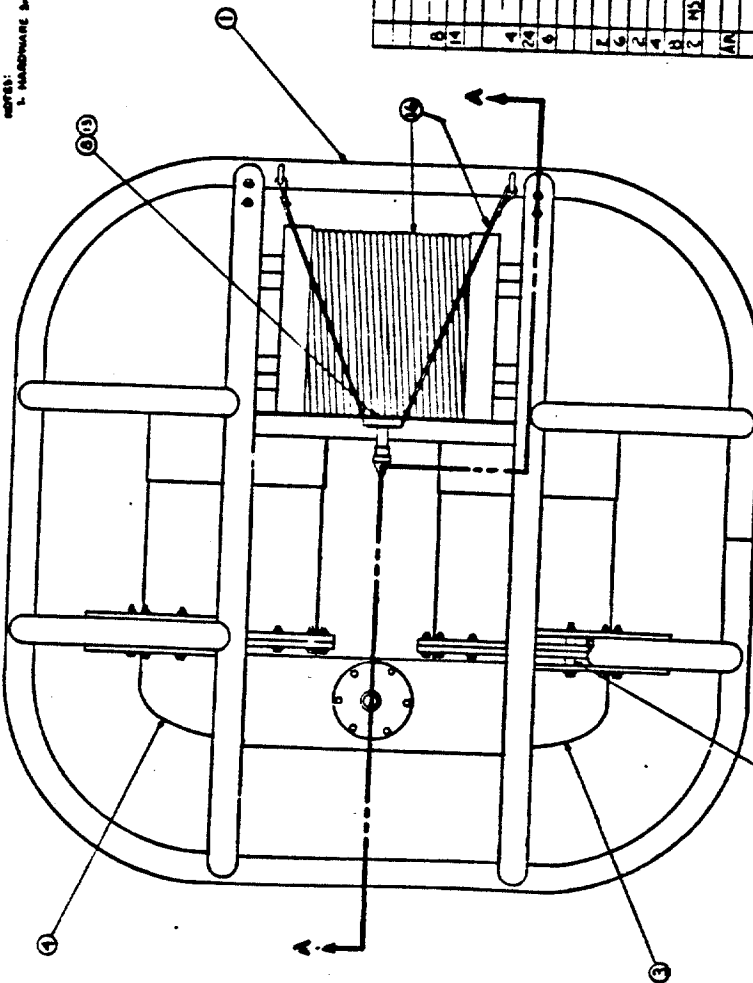
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FIG. 1

- Item 13 Explosive Bolt Release Mechanism: used to release the Recovery Float. It is actuated by the system electronics upon command from the surface.
- Item 14 Telemetry Transducer: used to send and receive acoustic signals from the shipboard command unit. All data recovered and all instructions to SEMS are transmitted in this fashion.

The cross section of the Seismic Probe (Fig. 2) shows the construction and the principal parts of that assembly.

- Items 4,5 Protective Cover: O-ring sealed Teflon cover designed to protect the probe from corrosion, match soil bulk density, and protect the unit from handling and installation shocks.
- Items 1,6 Housing and End Cap: aluminum pressure vessel housing all internal components.
- Item 23 Accelerometer: one of three orthogonally oriented seismic accelerometers.
- Item 24 Magnetometer: two-axis magnetometer for reading north-south orientation of the probe.
- Item 25 Bulkhead Connector: electrical interface between internal components and the 12-conductor probe cable.

The magnesium tube handle, shown as Item 28, has been deleted. Accordingly, Item 3, the Handle Adapter, is being modified to simply restrain the cable and connector to prevent overflexing during handling and installation.

A description of the costs and specifications for the unit appear in Table 1. The purchase cost of hardware, assembly

TABLE 1.

SEMS : PHYSICAL DESCRIPTION AND OPERATING SPECIFICATIONS

COMPONENT OR CHARACTERISTIC	DESCRIPTION OR VALUE
1. COST :	
HARDWARE	\$ 72.000
ASSEMBLY	\$ 35.000
DEPLOYMENT	\$ 25.000
TOTAL COST DEPLOYED	\$ 132.000
TOTAL LIFE CYCLE COSTS	\$ 175.000
2. SYSTEM LIFE	BATTERIES AND PRESSURE RATED SEALS DESIGNED FOR 5 YEARS OPERATION. STATED LIFE : 4 YEARS
3. CONTROLLER	RCA 1802 MICROPROCESSOR MONITORS PROBE AT A SAMPLING RATE OF 100/SEC PER ACCELEROMETER AND CONTROLS MEMORY AND TELEMETRY FUNCTIONS
4. MEMORY	1520 SEC OF MAGNETIC BUBBLE MEMORY ARRANGED IN ADDRESSABLE 23.8 SEC BLOCKS
5. TELEMETRY SYSTEM :	
SLANT RANGE	1000 METERS
ANTENNA PATTERN	140 DEGREE CONICAL BEAM
TRANSMISSION RATE	1200 - 2400 BITS PER SECOND
6. PROBE MAGNETOMETER	2-AXIS, 1.5 DEGREE ORIENTATION MEASUREMENT ACCURACY
7. PROBE ACCELEROMETERS :	
MODEL	ENDEVCO 7751-500 SOLID STATE
DYNAMIC RANGE	10.000 OVER 0.0001 TO 10.0 G
FREQUENCY RESPONSE	0.2 - 1500 HZ (+/- 5%) 0.1 - 1500 HZ (+/- 10%, CALIBRATED)
FREQUENCY RANGE	5 - 1500 HZ, PHASE SHIFT <2 DEGREES
NATURAL FREQUENCY	0.1 - 20 HZ, PHASE SHIFT CALIBRATED 7000 HZ
8. TIME ACCURACY	(+/-) 100 MILLISEC RELATIVE TO WWV TIME

costs, and deployment costs sum to produce the "Total Cost Deployed." "Total Life Cycle Costs" include the "Total Cost Deployed" plus the additional costs of monitoring the unit, gathering and reducing data, and recovering the unit at the end of life.

The other items in the table describe the technical specifications for the unit. Once in operation, the system microprocessor monitors the three-axis accelerometers. When incoming signals exceed 1.5 times the background level for two seconds, an event is declared. At the same time the magnetic bubble memory is activated and searched. Should the incoming event be stronger in magnitude than any earthquake stored in memory, it will replace the weakest event. Storage occurs in 24 second blocks, which may be linked if the quake continues beyond 24 seconds. When the incoming signals drop below 1.2 times the earlier background level, the microprocessor declares the event over and shuts down the nonvolatile memory to conserve power.

The system microprocessor also controls the acoustic telemetry system. Upon command from the shipboard telemetry system used to communicate with SEMS, it will respond with its data and information on its operating condition. Memory blocks can then be remotely cleared, the internal clock read and reset to WWV time, and certain operational triggers reset, if desired.

4.0 Summary of Accomplishments

During this quarter all design drawings not previously completed were finished and released. Drawings are placed in the Sandia Film Bank and thus all major components and assemblies are documented for future reference.

On October 30, a meeting was held at Shell Development Company, Houston. The purposes of the meeting were to discuss the design of the SHELL unit, possible deployment sites in the Beta field, and deployment procedures. Attending for SHELL were

Raul Husid (earthquake engineering)
George Sgouros (soils engineering)
George Rodenbusch (oceanography)

Representing Sandia were

James Hickerson (project engineering)
Al Lopez (electronics and software)
Fred Norwood (dynamic analysis)

The principal actions taken at the meeting were as follows:

1. Low power Endevco accelerometers were chosen for use in the seismic probe. This allowed the design life of the unit to be restated as 5 years, due to decreased battery drain, with only a slight loss in sensitivity over the baseline Sundstrand accelerometers.
2. An area was identified NE of the Ellen-Elly platforms in blocks 261 and 262 that was deemed suitable for SEMS deployment. Water depth in the area is about 250 feet, gradients are about 3%, and seabed soils are fine sandy silt.

As a result of this meeting, design changes have been made to incorporate the Endevco accelerometers, and a reappraisal of system seals has been made to assure a 5-year submerged life capability.

Based on the reappraisal of seals, a decision was made to rework pressure vessel seals to improve sealing surface quality, and it was also decided to change all external cable assemblies to incorporate metal shell, double O-ring sealed connectors. This, in turn, has caused some delays and is partially responsible for the decision to reschedule deployment from January 31 to April 3.

Discussions and negotiations were also begun with GEOMAREX on methods of deployment and terms for a contract. It was decided in early October that a man-assisted procedure for emplacing the seismic probe would be more reliable than a remotely operated, mechanical method. The general method adopted is to drill a 6-7 foot deep hole near the Seafloor Platform and then use a manned submarine to insert the probe into this hole. Afterwards, the casing will be removed from the hole and the hole backfilled. This sequence is described in detail in the Appendix.

We are now in the final stages of contract negotiation with GEOMAREX to perform these tasks and handle logistics. Field tests will be run in late January and again in early March to verify the operation of the drilling equipment and to test the procedures for inserting and removing the casing.

Fred Norwood, Solid Dynamics Department, completed an analysis in December that is government funded but has bearing on this project, although its principal intent was to define conditions for our Bering Sea project. Fred has analyzed those conditions of ocean wave action that would create seismic background noise and has written an interactive computer program that allows us to estimate background noise knowing wave height and water depth. We are working with this program now and expect to have a prediction of seismic sensitivity

limits of the probe due to all sources of noise prior to deployment . We presently believe that these noise levels will be very low for the SHELL unit, and also low for the Bering Sea sites now being considered.

APPENDIX

PROPOSED SITE AND DEPLOYMENT PROCEDURES

Proposed Site and Deployment Procedures

Figures 3 and 4 show the general area and the specific site proposed for the SHELL SEMS. The site lies in the NE corner of SHELL Block 261, 2000 feet due NE of borehole 261-7. Borehole 261-7 lies directly under the bridge connecting the Ellen-Elly platforms.

Water depth at the site is 235 feet. Surface sediments are believed to be fine, silty sand, sloping at a gradient of 3% to the SE. Principal geological features near the site are the presence of rock outcrops located approximately 1000 feet to the NE and S, and the San Gabriel canyon edge about 2000 feet to the E.

The installation of the SHELL unit will be coordinated and supported by GEOMAREX of La Jolla, California. The procedures to be used are being jointly established by Sandia and GEOMAREX, and will require the assistance of a manned submarine for the purposes of reconnaissance, photography, and emplacement of the seismic probe. The planned sequence of events during deployment is shown in Figure 5. The SEMS Seafloor Platform (Figure 1), carrying the Seismic Probe and cable (Figure 2) is first lowered to the seafloor (Figure 5a). Submarine reconnaissance will be used to assess the suitability of the site. Next, a modified GEOMAREX P4 Vibracorer will be lowered to drill a 7-foot deep hole 10 to 15 feet distance from the SEMS (Figure 5b). At the same time, a temporary split casing will be driven with the coring tool in order to prevent the collapse of the hole. After the hole is drilled, the P4 Vibracorer will be lifted a few feet above the seabed. A tether between the P4 and the split casing will link the two and be used for later withdrawal of the casing. The submarine will then retrieve the Seismic Probe from the Seafloor Platform and emplace it in the drilled hole. The configuration at this

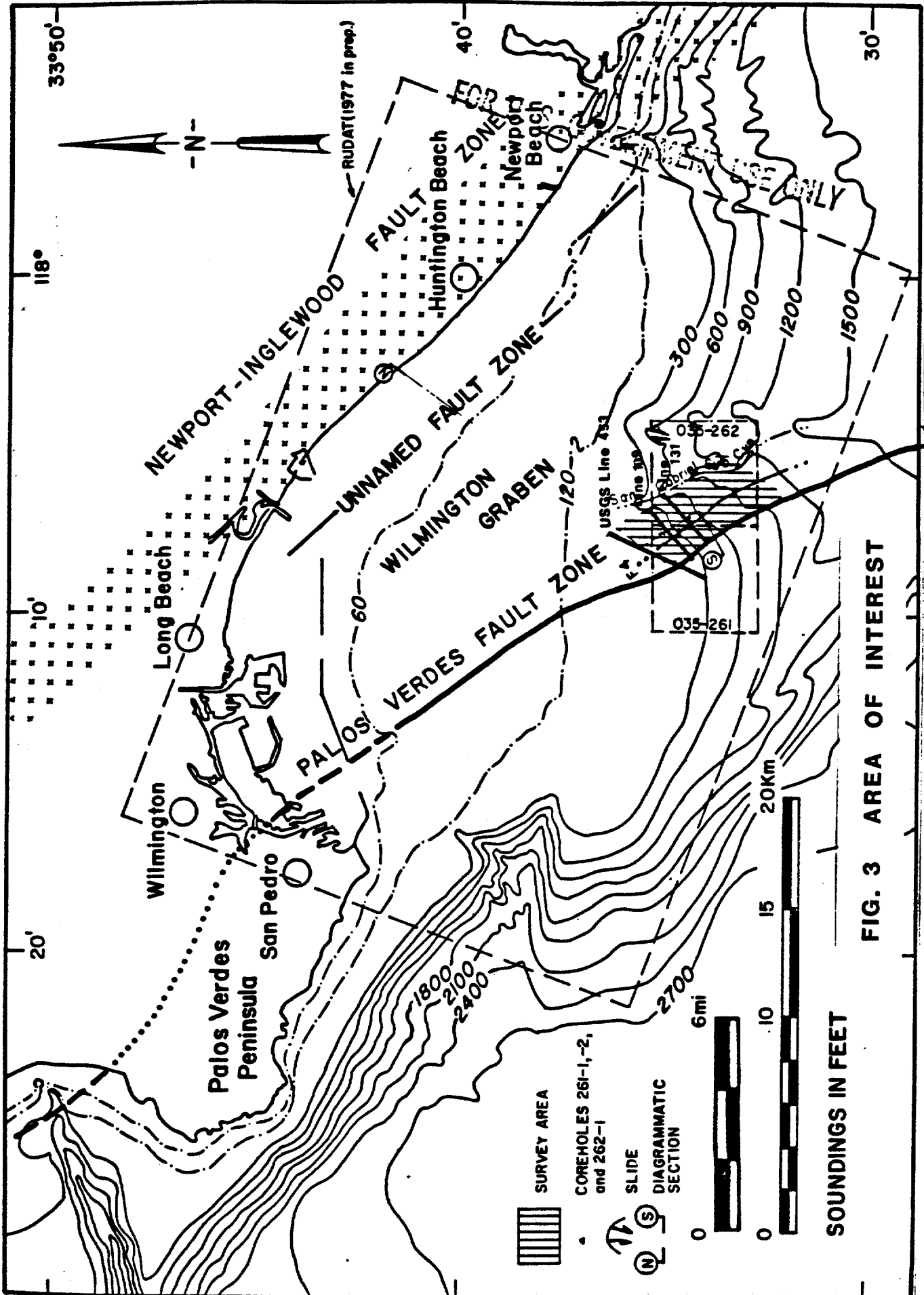


FIG. 3 AREA OF INTEREST

Figure 3.

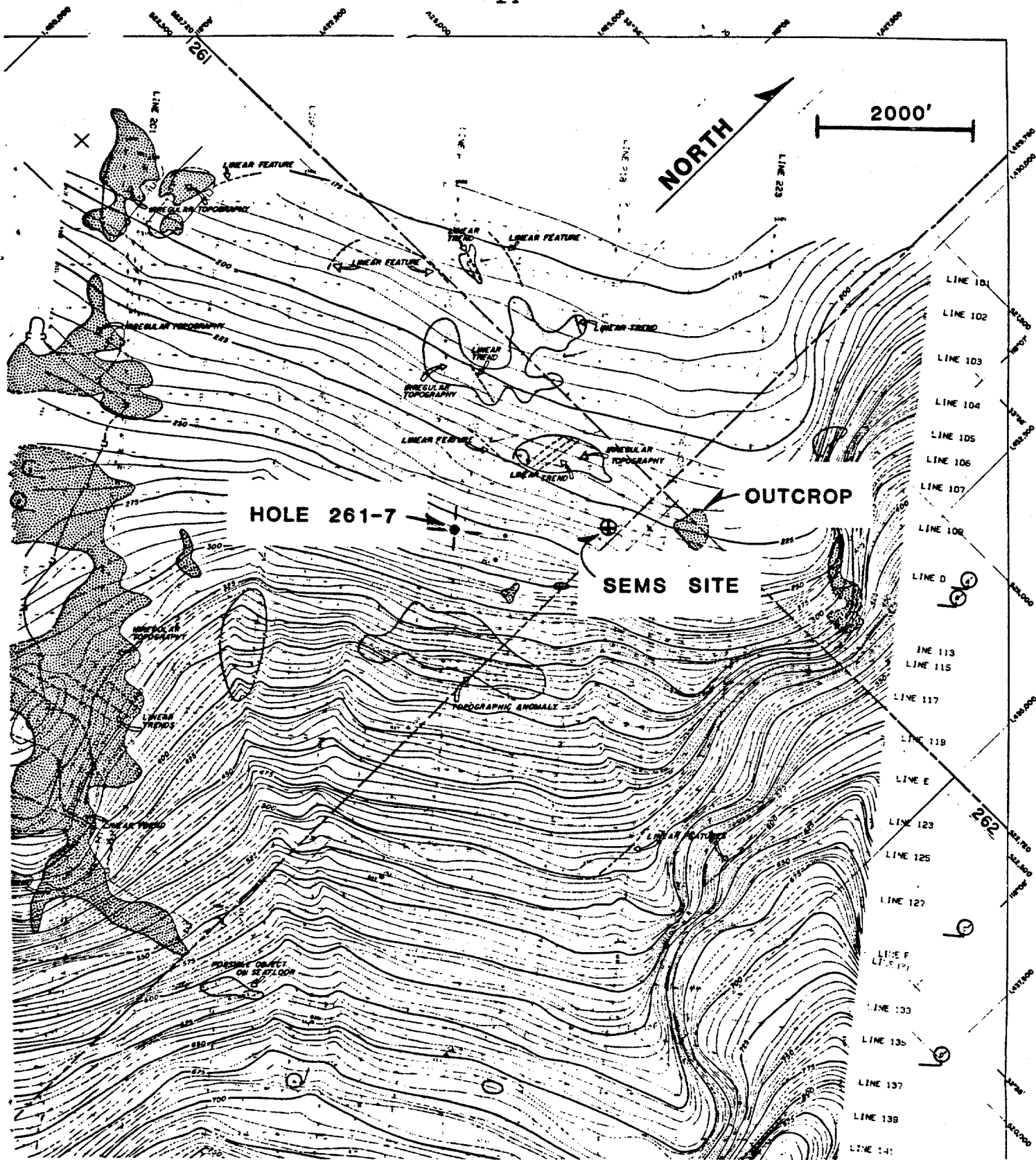


FIG. 4 PROPOSED SEMS SITE

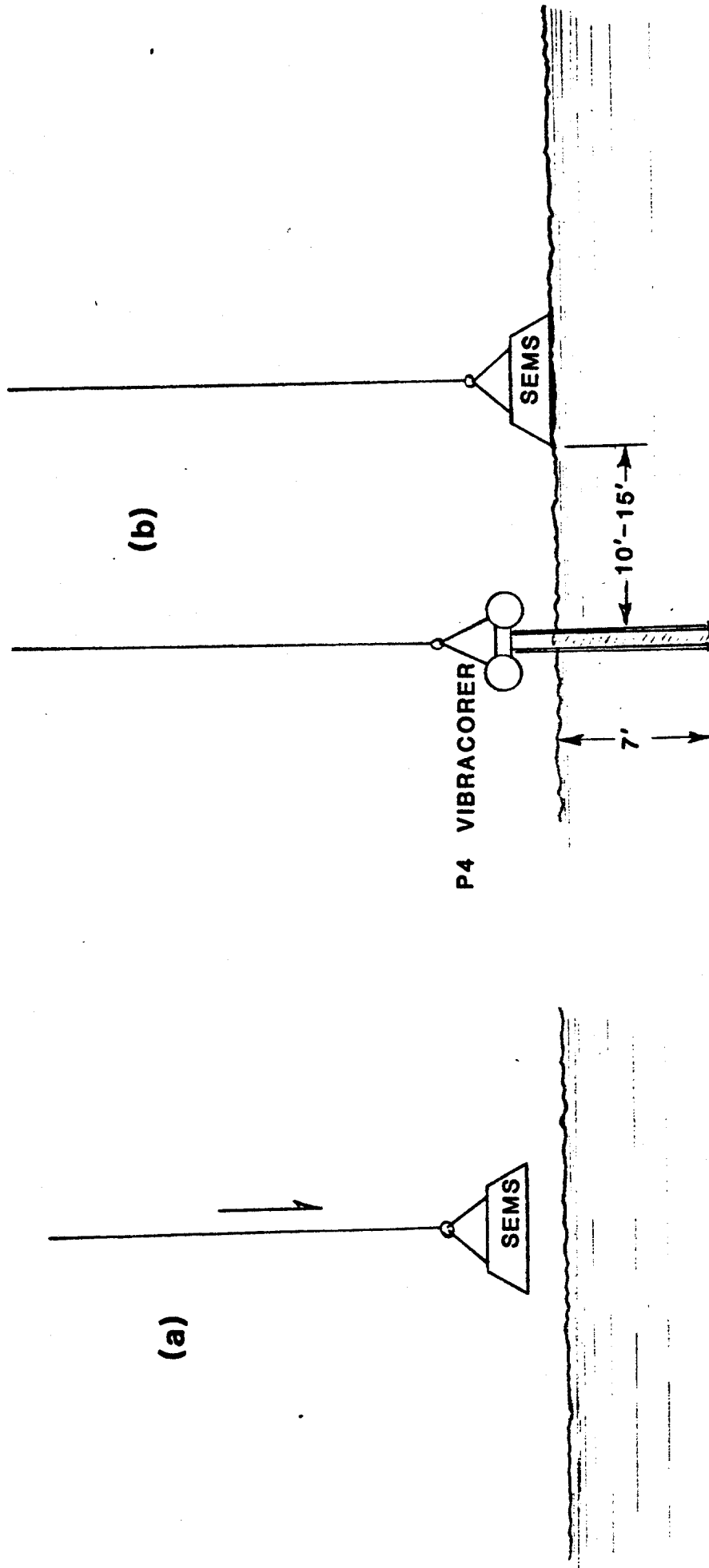


FIG. 5 DEPLOYMENT SEQUENCE

point is illustrated in Figure 5c. Finally, the casing will be withdrawn by hoisting the P4, and the line attached to the Seafloor Platform will be remotely released and withdrawn (Figure 5d). The submarine will finish up by using its ballasted weight and manipulator to collapse the hole.

During installation, acoustic communication will be maintained with the submarine and the SEMS by the shipboard party. Observers on board the submarine will be instructed to monitor the events underwater for possible errors or malfunction. After each step in Figure 5, the health of the SEMS will be checked before proceeding.

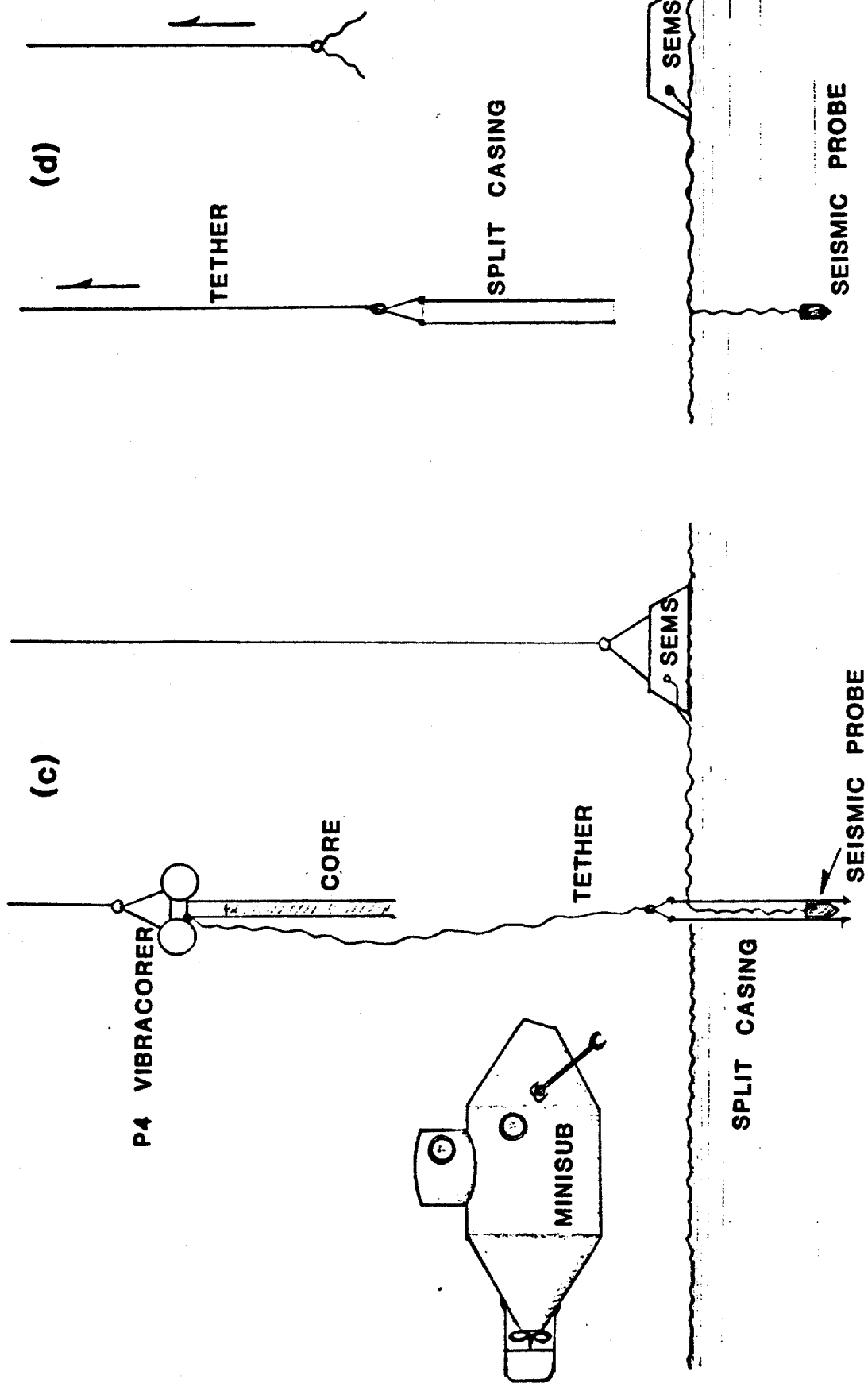


FIG. 5 (cont.)

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